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## A note on the structural dimorphism of sexual and tetrasporic plants of *Galaxaura obtusata*

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In a monograph of *Galaxaura*, a genus of calcified red algae of the family Chaetangiaceae, published by the late Professor Kjellman of Upsala in 1900,\* two groups of species, denominated the "Cameratae" and the "Spissae," are recognized in the section *Dichotomaria*, the section that includes the West Indian *Galaxaura obtusata* (Ell. & Sol.) Lamour. and its allies. The plants of these two groups differ markedly and constantly in the structure of the cortex, as may be determined by a microscopic examination, particularly after decalcification. In both groups, the cortex consists essentially of three layers of cells. In the "Cameratae," the cells of the outermost or superficial layer are funnel-shaped or broadly obconic and are supported by the cylindric, clavate, or narrowly funnel-shaped, widely spaced cells of the middle layer, which, in turn, spring from the very large firmly united cells of the inmost layer; the funnel-shaped superficial cells are in contact by their edges only and they arch over large intercellular chambers, which are continuous or confluent, being bounded below by the large cells of the inmost layer and merely traversed rather than bounded by the widely spaced stalk-cells; in other words, the single superficial layer constitutes a sort of a roof or outer sheath, supported by short pillars. In the "Spissae," the cells of the outermost or superficial layer are hemispheric or saucer-shaped and are supported by the ovoid or subglobose, connivent or rather close-set cells of the middle layer, which, in turn, rest upon the large firmly united cells of the inmost layer; the intercellular spaces are comparatively small and instead of obviously extending from the superficial layer to the inmost layer they are commonly divided into two series or strata by the rounded connivent cells of the middle layer. In other words, the middle layer of the

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\* Kjellman, F. R. Om Floridé-släktet *Galaxaura*, dess organografi och systematik. Kongl. Sv. Vet.-Akad. Handl. 33<sup>1</sup>: 1-109. pl. 1-26. 1900.

cortex in the "Cameratae" consists chiefly of large obviously confluent intercellular *chambers* filled with lime, while in the "Spissae" this middle layer is made up chiefly of rounded calcified *cells*. Expressed in another way, it may be said that the two outer layers of the cortex in the "Cameratae" are filamentous, if two cells in a row (or, often, two or three cells supported capitately by a single stalk-cell) may be said to constitute a filament, while in the "Spissae," the cortex is parenchymatous or subparenchymatous throughout. In the process of decay or on teasing to pieces with needles after decalcification, it often happens that the outer cortex peels off, leaving the inner cortex still surrounding the central strand of filaments. In the "Cameratae", such a separation commonly takes place near the base of the stalk-cells constituting the middle layer, so that the two outer layers are exfoliated together, leaving the stumps of the stalk-cells protruding from the large firmly coherent cells of the inmost layer. In the "Spissae," the separation under such circumstances takes place between the two outer layers, only the single superficial layer being exfoliated, the middle layer of rounded subparenchymatous cells remaining firmly attached to the larger cells of the inmost layer.

In the course of a microscopic examination of certain specimens of *Galaxaura* from Bermuda, Florida, and the West Indies, representing forms currently referred to *G. obtusata*, it was noted that some of these specimens showed the cortex structure of the "Cameratae" group while others showed that of the "Spissae" group. It was at first supposed that two or more species were represented in this material, but it was afterwards observed that the two forms were often collected together almost throughout their range, that they showed the same or parallel variations in external characters, and that they could not be separated without a microscopic examination. A little later it was noted that whenever reproductive organs could be found (and by search they could be found in most of the specimens), the plants of the "Cameratae" structure were always tetrasporic, while those of the "Spissae" structure were always antheridial or cystocarpic. This discovery led to a careful reexamination of all the available material, with results that were confirmatory of this correlation.

One of the largest single collections at hand was that made by the writer on Condé Beach, Guantánamo Bay, Cuba, in March, 1909 (*no.* 6460), where nineteen plants or fragments of plants were picked up on the shore (the species is apparently an inhabitant of rather deep water and is found washed ashore or by dredging in 7-18 meters). Of these nineteen, three were antheridial and of the "Spissae" structure, three were cystocarpic and of the "Spissae" structure, twelve were tetrasporic and of the "Cameratae" structure, and the remaining one was apparently sterile and of the "Cameratae" structure. Of five plants dredged in 18 meters off Ratones Island near Ponce, Porto Rico (*no.* 7575), four belonged to the "Cameratae" and were tetrasporic, and one belonged to the "Spissae" and was cystocarpic. Of numerous plants or fragments dredged in 7-10 meters at the mouth of Guanica Harbor, Porto Rico (*no.* 7005), all of the thirteen examined showed the "Spissae" structure, three or four of them being evidently antheridial, one cystocarpic, and the rest apparently sterile. Of five plants found washed ashore in the harbor of Port Morant, Jamaica (*no.* 6276), two had the "Spissae" structure and were cystocarpic, while three showed the "Cameratae" structure, though tetraspores could actually be found on only one of the three. In six plants from Barbados, similar to each other in general habit, though not all collected at the same time and place, five were "Cameratae," four of them with obvious tetraspores, while the sixth showed the structure of the "Spissae" group and was cystocarpic. On the coast of Florida also, in the region of Jupiter Inlet, Indian River, and Lake Worth, in plants that are somewhat larger, coarser, and longer-segmented than the typical *Galaxaura obtusata*, the same correlations may be observed.

Finally, it is to be noted by consulting Kjellman's monograph, that all of the species that he placed in the group "Cameratae," in so far as their mode of reproduction was known to him, are tetrasporic, while of the "Spissae" the one species of which the reproductive organs are described is cystocarpic.

For complete proof that the "Cameratae" structure is a constant characteristic of the tetrasporic plants of *Galaxaura obtusata* and its allies and that the "Spissae" structure is likewise a constant character of the sexual plants, it would of course be desirable that

actual cultures should be made under control conditions as has been done by Hoyt\* and by Lewis† to demonstrate the alternation of generations in certain other tetraspore-producing algae. This could be done only in tropical or subtropical waters, would probably require months for its accomplishment, and is not likely to be achieved in the immediate future. Meanwhile, however, it seems to the writer that the proof is conclusive that the suggested correlation exists, that the "Spissae" and "Cameratae" characters, first accurately pointed out by Kjellman, do not offer a proper basis for subgeneric groupings of species as supposed by him, but merely distinguish the gametophytic and sporophytic phases in the life-cycle of a single species.

It is well known that differences of habit occur between sexual and tetrasporic plants of certain red algae, as, for example, in species of *Griffithsia*, but such differences seem to be due largely to the presence of the reproductive organs themselves or to differences in the form of the cells that are rather directly concerned with their production. So far as is known to the writer of these notes, there has been no previous record of a case in which there has been alleged to exist any such constant and pronounced dimorphism in the purely vegetative microscopic structure of the sexual and tetrasporic plants in the Rhodophyceae as is here attributed to *Galaxaura obtusata*—differences that do not express themselves in general habit, but afford an easy means of distinguishing a tetrasporic from a sexual plant, even though apparently sterile.

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\* Hoyt, W. D. Alternation of generations and sexuality in *Dictyota dichotoma*. Bot. Gaz. 49: 55-57. 1910.

† Lewis, I. F. Alternation of generations in certain Florideae. Bot. Gaz. 53: 236-242. 1912.